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Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

5 DEC 1998

The Patent Office

Cardiff Road
Newport
Gwent NP9 1RH

1. Your reference

AA 1438 GB

2. Patent application number
(The Patent Office will fill in this part)

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

JOHNSON MATTHEY PUBLIC LIMITED COMPANY

2-4 COCKSPUR STREET
TRAFALGAR SQUARE
LONDON SW1Y 5BQ

Patents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation

GB 00536081007

4. Title of the invention

IMPROVEMENTS IN PARTICULATE CONTROL

5. Name of your agent *(if you have one)*

IAN CARMICHAEL WISHART
JOHNSON MATTHEY TECHNOLOGY CENTRE
BLOUNTS COURT
SONNING COMMON
READING RG4 9NH

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

Patents ADP number *(if you know it)* 07255310001

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Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

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DUPLICATI

Case AA 1438

IMPROVEMENTS IN PARTICULATE CONTROL

The present invention concerns improvements in the control of particulate emissions from internal combustion engines. More particularly, it concerns the control of "wet" soot, typically from naturally aspirated diesel engines.

There are a great many naturally aspirated diesel engines used throughout the world in vehicles, maritime craft and in stationary power sources. Although many modern engine designs utilise turbo-charging, there is a huge population of naturally aspirated engines, and this will be the case for the foreseeable future. Also, it is to be noted than in some countries, including particularly Japan, the performance enhancements from turbo-charging are not adjudged to be worthwhile, and indeed for some markets, turbochargers are removed from modern engines during truck or bus building or re-building. All diesel engines generate soot or carbonaceous particulates, but the soot from naturally aspirated engines is "wet" soot, that is carries a considerable proportion of hydrocarbons absorbed into the particles. Although the present invention has particular application to naturally aspirated diesel (compression ignition) engines, it may also find application in other engine designs which generate such particulates.

We have previously disclosed and claimed continuously regenerating technology (see USP 4902487), in which NO_2 combusts soot at lower temperatures than simple oxidation using oxygen itself. This has been commercialised by Johnson Matthey under the trademark "CRT", and is a particularly effective system for removing particulates from heavy duty diesel engines. However, wet soot is dealt with less effectively than dry soot from turbocharged engines. There is great public interest in removing particulates from the exhaust gases of naturally aspirated diesel engines, as these are especially visible signs of pollution, and there are also health concerns about the types of hydrocarbon on the soot.

r promoting elements may also be present. The ceria may be present as a washcoat over a platinum-catalysed alumina or over another catalyst.

The second zone preferably comprises a high loading platinum on alumina catalyst, capable of converting NO to NO_2 , and is generally of known type.

The gas flow rate, and space velocity, applicable to the first and second zones are suitably in the range commonly met with in diesel exhaust gas treatment devices.

It is possible to contemplate a single catalyst monolith or "brick", one end of which carries the first catalyst, and the other end of which carries the second catalyst, providing appropriate catalyst design and catalyst manufacturing technology is used, and providing that gas flow rates and space velocities are suitable.

The filter may be a ceramic wall flow filter, a ceramic foam filter, ceramic fibre filter or a wire mesh filter of any suitable type, and may provide for removal of 50 to 100 wt%, preferably at least 60 wt%, more preferably 85 wt% or greater, of the measured particulates in the exhaust gases. There may be a fail-safe bypass or a two stage filter to cater for a situation where the filter would otherwise be blinded and blocked under certain engine operating conditions. If desired, the filter may be catalysed to assist combustion. A variety of catalysts are known to be suitable, and these include one or more of oxides of vanadium, cerium, and mixed Cs/La/V oxide. The invention includes the possibility of initiating combusion of the soot if required, for example if the engine operating conditions are such that considerable soot is being/has been generated but the gas temperatures are rather too low for significant combustion, for example by providing electric heating of a portion of the filter.

It is believed, although we do not wish to be restricted by any theory, that the system and process of preferred embodiments of the invention, whilst permitting combustion of hydrocarbons in the first zone, generates sufficient NO_2 in the second zone to provide the right balance of NO_2 to carbon for combustion in the particulate trap, under typical diesel operating conditions.

Table 1

Exp	Sample	Pt-loading (Wt%)	DTA onset temp (^{o}C)	DTA peak area (μV-S/mg sample)
1	γ-alumina	0.0	226	1098
2	γ-alumina	0.25	209	1108
3	ceria	0.0	134	2104
4	ceria	0.009	138	2165
5	ceria	0.0375	140	2125
6	ceria	0.25	132	2361

It can be seen that both samples of γ-alumina have a relatively high DTA onset temperature, but all samples of ceria show a very significant reduction, into the range of temperatures commonly met with in diesel exhaust gases. All the ceria-based tests illustrate significant combustion of the hydrocarbon oil at low temperatures.

Additional tests were carried out in essentially the same manner, but using mixtures of ceria and platinum catalysed γ-alumina, with one or both of the ceria and alumina impregnated with 10 wt% of oil. The results are shown in Table 2 below.

Table 2

No	Sample	Pt (Al_2O_3) Loading (wt%)	DTA Onset temp(^{o}C)	DTA Peak Area
1	$Ceria^{OIL}$/alumina	0.25	147	1182
2	Ceria/$alumina^{OIL}$	0.25	159	1147
3	$ceria^{OIL}$/$alumina^{OIL}$	0.25	156	1355
4	$(ceria/alumina)^{OIL}$	0.25	148	1915

CLAIMS

1. An exhaust gas treatment system suitable for exhaust gases from naturally aspirated diesel engines and like gases, comprising a first catalytic zone effective to cause combustion of at least the majority of the hydrocarbons absorbed on soot particles in the exhaust gases, a second zone comprising means to generate NO_2, and a third zone comprising particulate trapping means capable of trapping the majority of the soot particles in the gases, whereby such soot particulates are combusted by reaction with the NO_2 generated in the second zone.

2. A system according to claim 1, wherein the first catalytic zone comprises ceria.

3. A system according to claim 2, wherein the first catalytic zone further comprises a platinum group metal, optionally dispersed on a metal oxide support.

4. A system according to claim 1, 2 or 3, wherein said second zone comprises a platinum catalyst.

5. A system according to any one of the preceding claims, wherein the particulate trapping means is effective to trap at least 85 wt% of the particulates in the exhaust gases.

6. A system according to any one of the preceding claims, comprising also means to absorb or reduce NOx downstream of the system.

7. A process for the treating of gaseous emissions comprising NO, O_2 and sooty particulates on which are absorbed hydrocarbons, comprising passing said emissions through a first catalytic zone under conditions under which at least the majority of said absorbed hydrocarbons are combusted, generating NO_2 in a second zone and in a third zone, trapping at least 50 wt% of said particulates and combusting said trapped particulates by reaction with NO_2.

8. A process according to claim 7, wherein the NO_2 is generated by passing exhaust gases through

IMPROVEMENTS IN PARTICULATE CONTROL

Abstract of the Invention

Exhaust gases from naturally aspirated diesel engines, containing "wet" soot, are passed through a first catalytic zone, eg containing ceria, to combust the hydrocarbons absorbed on the soot, before the gases are passed through another catalyst effective to convert NO to NO_2. A particulate trap or filter traps a desired level of particulate, and these are combusted by reaction with the NO_2 at low temperatures.

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